

Supplementary Online Content

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This supplementary material has been provided by the authors to give readers additional information about their work.

eMethods. The Coronary Artery Risk Development in Young Adults (CARDIA) Study
Methods

The CARDIA study began in 1985-1986, enrolling 5,115 black and white adults ages 18 to 30 years who were recruited in Birmingham, Alabama; Chicago, Illinois; Minneapolis, Minnesota; and Oakland, California.¹ The cohort is balanced with respect to race (52% of the participants are black), sex (55% are women), and educational level (40% have ≤ 12 years of education). Serial follow-up examinations were conducted 2 (Y₂), 5 (Y₅), 7 (Y₇), 10 (Y₁₀), 15 (Y₁₅), 20 (Y₂₀) and 25 (Y₂₅) years after baseline (Y₀). Ninety-four % of the surviving cohort completed at least one phone interview or examination from 2009-2014.

BP measurement

Systolic blood pressure (SBP) and diastolic BP (DBP) were measured at each CARDIA examination following standardized protocols; the details are described in *National Heart Lung and Blood Institute, Coronary Artery Risk Development in Young Adults (CARDIA) Study Manual of Operation, 1985*.

<http://www.cardia.dopm.uab.edu/exam-materials2/manual-of-operations/year-0>.

Briefly mentioned,

1. Research staff were carefully and centrally trained prior to participating. Prior to certification, each technician had their vision and hearing tested by reading and auditory (Korotkoff sound tape) tests, respectively. Recertification occurred every six months according to the instructions in the Manual of Operations.
2. Staff chose the correct cuff size and wrapped the cuff around the arm with the center of the bladder over the brachial artery. Close attention was paid to the equipment to ensure that BP measurements had a standardized high level of accuracy and precision; equipment includes stethoscope, random-zero and standard sphygmomanometers, and cuff and bulb. The appropriate BP cuff size was determined by measuring the participant's arm circumference at the mid-point between the acromion and olecranon; the pediatric cuff was used for arm circumferences (AC) less than 24.5 cm, the standard adult cuff for ACs of 24.5-33 cm, the large adult cuff for ACs of 33-41 cm, and the thigh cuff for ACs above 41 cm.
3. Research staff measured right-arm brachial artery BP 3 times after the participant had been sitting in a quiet room for 5 minutes. The inner aspect of the bend at the elbow (cubital fossa) was maintained at heart level and the legs were uncrossed.

4. Measurement: staff inflated the cuff to the R-Z peak inflation level, holding the pressure constant with the bulb (wait 5 seconds), placed the bell of stethoscope on the brachial artery, and slowly deflated the cuff (2 mmHg per second). Staff recorded the 1st and 5th Korotkoff sounds, reading the pressure in mmHg to the nearest even number and recording it.
5. Caffeine, eating, heavy physical activity, smoking, and alcohol intake were proscribed for two hours prior to BP recording.
6. BP measures were made before the physical examination, blood drawing, treadmill test, or any stressful interview.
7. BP measures were made in a separate room, or at minimum, in an area properly screened from all other activity and other participants.

At each examination, research staff measured right-arm brachial artery BP 3 times after the participant had been sitting in a quiet room for 5 minutes. Three measurements were taken at 1-minute interval, and the average of the 2nd and 3rd measurements was used for the analysis of office BP.¹ Members of the CARDIA research staff took measurements by using a Hawksley random-zero sphygmomanometer (Hawksley, Sussex, United Kingdom) until the Y₁₅ examination.

Data collection

Blood was drawn by venipuncture according to a standard protocol.² Total cholesterol was measured enzymatically. Glucose was measured at Y₂₅ using exokinase coupled to glucose-6-phosphate dehydrogenase by Linco Research (St Louis, MO). Diabetes was defined as a fasting glucose level of ≥ 126 mg/dl or treated diabetes.

Information on smoking status, education, and blood analysis was collected via standardized protocols and quality control across study centers. Current smoking status was defined as current, former, or never by self-report.

The A Priori Diet Quality Score (APDQS), which has been validated by demonstrating its association with cardiovascular risk,³⁻⁶ was assessed at Y₀. Details of the APDQS been described previously.³⁻⁶ Briefly, interviewers asked open-ended questions about dietary consumption in the past month within 100 food categories that referenced 1609 separate food items. Foods were assigned in one of 166 food groups using the food-grouping system devised by the University of Minnesota Nutrition Coordinating Center. Food-group intake was assessed as servings per day of constituent foods. We created a

dietary pattern score from the 46 foods groups as conducted in previous studies.³⁻⁶ The theoretical maximum score was 132. A higher APDQS indicates better diet quality.

Cardiovascular outcomes

We recorded incident cardiovascular disease (CVD) events through September, 2013. During their scheduled study examinations and yearly telephone interviews, each participant or designated proxy was asked about interim hospital admissions, outpatient procedures, and deaths. Medical records were requested for participants who had been hospitalized or received an outpatient revascularization procedure.

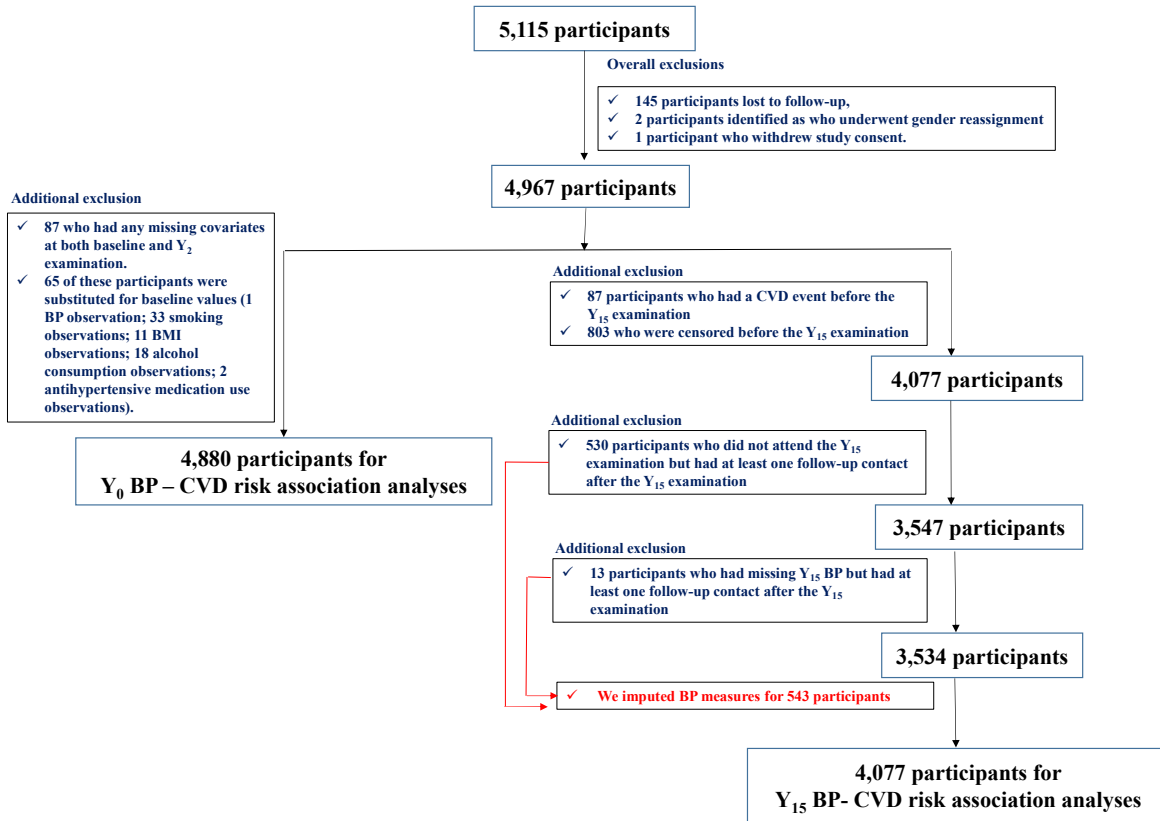
Vital status was assessed every 6 months; medical/death records were requested after consent had been obtained from the participants or next of kin. Two physician members of the Endpoints Committee independently reviewed medical records to adjudicate each possible CVD event or underlying cause of death using specific definitions and a detailed manual of operations (<http://www.cardia.dopm.uab.edu>). If disagreement occurred between the primary reviewers, the case was reviewed by the full committee. Coronary heart disease (CHD) included hospitalization for myocardial infarction, acute coronary syndrome with or without evidence of myocardial necrosis, coronary artery revascularization, or CHD death (including fatal myocardial infarction). CVD included CHD, and hospitalization for heart failure (HF), stroke, transient ischemic attack, intervention for peripheral artery disease, or death from cardiovascular causes. Definitions of each outcome have been previously described.⁷⁻⁹ Participants who did not have events and who did not drop out of the study were censored at 28 years after the Y₀ examination.

References

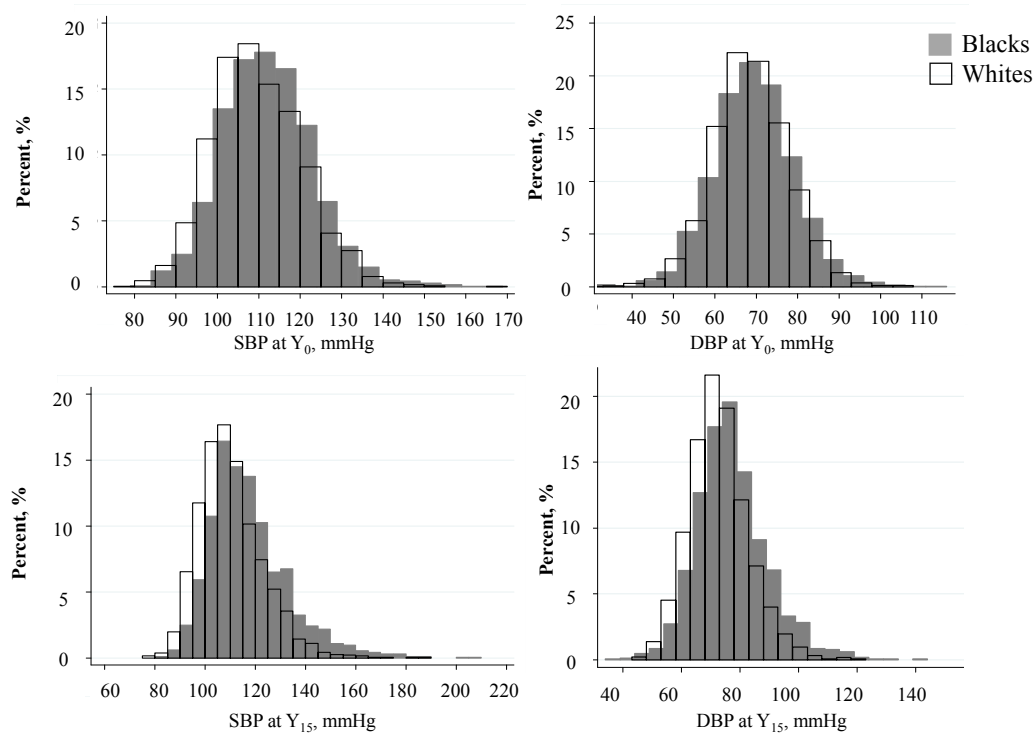
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eFigure 1. Flowchart: Sample for the Analyses, CARDIA

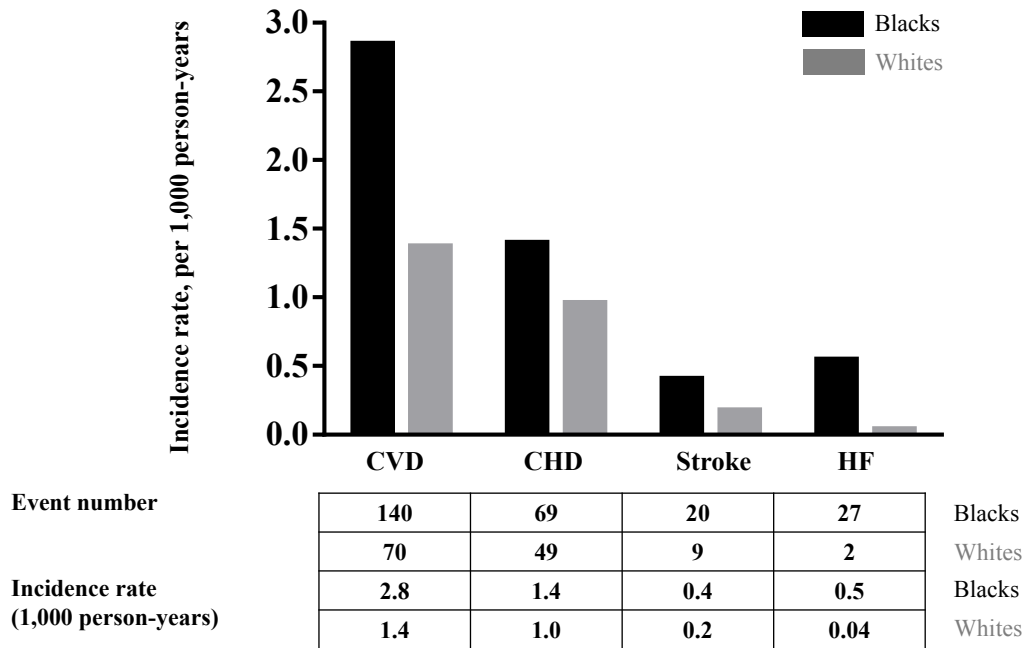


eFigure 2. Histogram of BP at Y_0 or Y_{15} in CARDIA



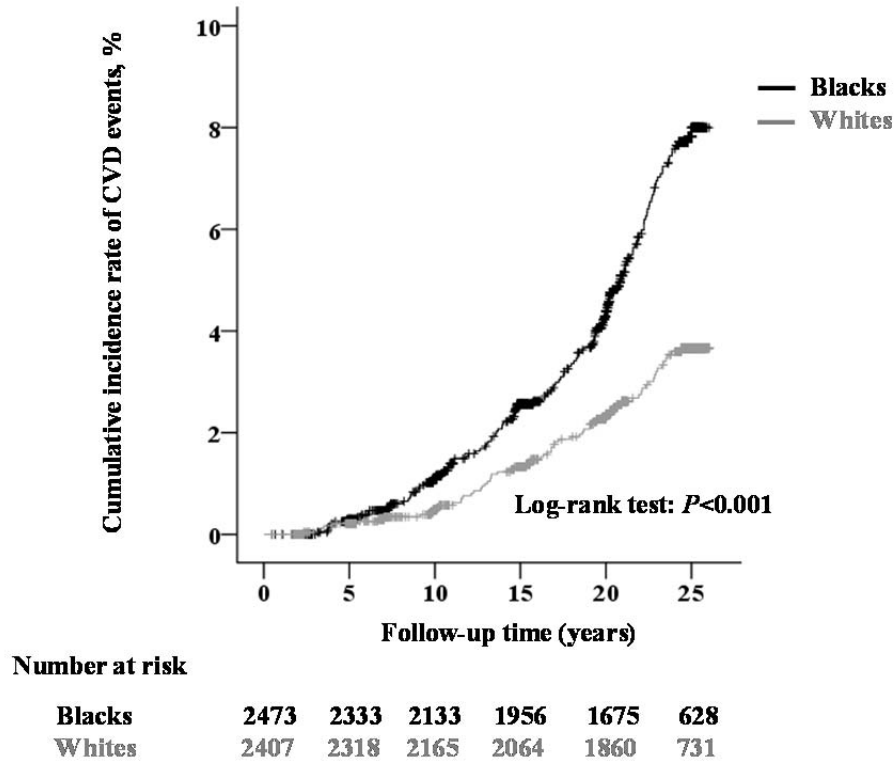
Race-specific distribution of SBP (left figures) and DBP (right figures) at Y_0 (upper figures) or Y_{15} (lower figures) based on all participants is shown. Gray bars represent BPs in blacks and transparent rectangles with black outlines represent BPs in whites.

eFigure 3. Cause-Specific Incidence Rates of Cardiovascular Outcomes by Race



Race-specific incidence rate of cardiovascular outcomes is shown. The definition of each color bar is as follows: black line, blacks; gray line, whites.

eFigure 4. Kaplan-Meier Curves of the Cumulative Incidence of CVD Event by Race



Race-specific cumulative incidence rate of cardiovascular disease (CVD) events is shown. CVD included coronary heart disease, stroke, transient ischemic attack, heart failure, and other vascular diseases. The definition of each color line is as follows: black line, blacks; gray line, whites. The log-rank was used to calculate P value.

eTable 1. Race-Specific Correlations of BP Components With the Demographic Variables and Clinical Characteristics at Y₀

Variables	Blacks (n=2,473)				Whites (n=2,407)			
	SBP	DBP	MAP	PP	SBP	DBP	MAP	PP
Age, years	0.09‡	0.19‡	0.17‡	-0.09‡	0.02	0.13‡	0.10‡	-0.11‡
Education, years	-0.003	0.07†	0.05*	-0.07‡	-0.02	0.05*	0.03	-0.07§
Body mass index, kg/m ²	0.22‡	0.18‡	0.21‡	0.06†	0.28‡	0.19‡	0.25‡	0.15‡
Fasting glucose, mg/dL	0.13‡	0.06†	0.10‡	0.08‡	0.17‡	0.12‡	0.15‡	0.08‡
Total cholesterol, mg/dL	0.09‡	0.11‡	0.12‡	-0.01	0.10‡	0.10‡	0.11‡	0.02
High-density lipoprotein, mg/dL	-0.02	-0.02	-0.02	-0.002	-0.21‡	-0.10‡	-0.16‡	-0.15‡
SBP	-	-	-	-	-	-	-	-
DBP	0.55‡	-	-	-	0.62‡	-	-	-
MAP	0.80‡	0.94‡	-	-	0.84‡	0.95‡	-	-
PP	0.56‡	-0.39‡	-0.06†	-	0.58‡	-0.28‡	0.04*	-

eTable 2. Race-Specific Correlations of BP Components With the Demographic Variables and Clinical Characteristics at Y₀

Variables	SBP	DBP	MAP	PP
Blacks (n=2,473)				
Sex				
Men (n=1,088)	115.7±10.7‡	70.6±10.4‡	85.6±9.2‡	45.1±10.7‡
Women (n=1,385)	108.3±10.1	67.5±9.4	81.1±8.7	40.8±9.0
Smoking status				
Current smokers (n=835)	111.7±10.8	68.0±10.2†	82.6±9.2*	43.7±10.0‡
Never and former smokers (n=1,638)	111.5±11.1	69.3±9.8	83.4±9.1	42.2±10.0
Antihypertensive medication				
Yes (n=79)	122.6±13.3‡	79.7±12.3‡	94.0±11.8‡	42.9±9.5
No (n=2,394)	111.2±10.7	68.5±9.7	82.7±8.8	42.7±10.0
Whites (n=2,407)				
Sex				
Men (n=1,135)	114.3±10.2‡	70.9±9.4‡	85.3±8.6‡	43.5±9.3‡
Women (n=1,272)	104.8±9.3	66.2±8.4	79.0±7.9	38.6±7.8
Smoking status				
Current smokers (n=639)	108.4±10.6*	66.5±9.5‡	80.5±9.0‡	41.8±8.9†
Never and former smokers (n=1,768)	109.6±10.9	69.0±9.0	82.6±8.7	40.6±8.9
Antihypertensive medication				
Yes (n=33)	121.6±11.3‡	77.8±11.2‡	92.4±10.2‡	43.7±9.9
No (n=2,374)	109.1±10.7	68.2±9.1	81.9±8.7	40.9±8.8

eTable 3. The Association Between Each BP Component at Y₀ and CVD Risk:
Race-Specific Hazard Ratios for Incident CVD Events

	Blacks (n=2,473)	Whites (n=2,407)
	HRs (95% CIs) per 1 SD of BP component	HRs (95% CIs) per 1 SD of BP component
Single BP measurement at Y₀		
SBP	1.35 (1.14-1.61)†	0.99 (0.96-1.01)
DBP	1.19 (0.99-1.41)	1.53 (1.16-2.01)†
MAP	1.28 (1.08-1.51)†	1.41 (1.09-1.84)*
PP	1.10 (0.95-1.28)	0.73 (0.53-0.99)*
Dual BP measurements (Y₀)		
Model 1:		
SBP	1.32 (1.09-1.61)†	0.82 (0.57-1.18)
DBP	1.05 (0.88-1.26)	1.73 (1.21-2.48)†
Model 2:		
MAP	1.31 (1.11-1.55)†	1.39 (1.07-1.82)*
PP	1.17 (0.99-1.36)	0.74 (0.54-1.82)

Race-specific adjusted HRs (95% CIs) for risk of incident CVD with a 1SD increment in SBP, DBP, MAP, and PP are shown. 1 SD increment of each BP parameter at Y₀ is as follows: SBP, per 11 mm Hg; DBP 10mmHg; MAP, 9 mmHg; PP, 10 mmHg. All models include sociodemographic characteristics: age, sex, education, and study site (Birmingham, Chicago, Minneapolis, Oakland), clinical characteristics at Y₀ (smoking, body mass index, fasting glucose, total cholesterol/high-density lipoprotein cholesterol, and antihypertensive medication use), and A Priori Diet Quality Score.

HR, hazard ratio; CI, confidence interval; SBP, systolic blood pressure; DBP, diastolic blood pressure; MAP, mean arterial pressure; PP, pulse pressure. Statistical significance was defined as $P < 0.05$. * $P < 0.05$; † $P < 0.01$; ‡ $P < 0.001$.

eTable 4. The Association Between Each BP Component at Y₀ and CVD Risk in Participants Without Receiving Antihypertensive Medication at Y₀: Race-Specific Hazard Ratios and Changes in Model Fit and Discrimination for Incident CVD Events

	Blacks (n=2,394)					Whites (n=2,374)				
Composite CVD events, No. (per 1,000 person-years ; 95% CIs)	124 (2.60; 2.18 to 3.10)					65 (1.29; 1.01 to 1.65)				
	HRs (95% CIs) per 1 SD of BP component	Likelihood Ratio χ^2*	AIC	BIC	C statistics (95% CIs)*	HRs (95% CIs) per 1 SD of BP component	Likelihood Ratio χ^2*	AIC	BIC	C statistics (95% CIs)*
Base model	-	81.92	1780.35	1843.93	0.685 (0.617-0.753)	-	92.35	910.20	973.70	0.716 (0.638-0.793)
Base model +single BP measurement (Y₀)										
SBP	1.34 (1.12-1.62) †	91.11†	1773.15	1842.52	0.696 (0.629-0.762) †	1.16 (0.87-1.54)	93.39	911.16	980.43	0.714 (0.636-0.792)
DBP	1.23 (1.02-1.47) *	86.82*	1777.44	1846.81	0.688 (0.620-0.757)	1.48 (1.13-1.96) †	100.20†	904.35	973.62	0.724 (0.647-0.800) †
MAP	1.31 (1.10-1.57) †	90.25†	1777.01	1843.38	0.693 (0.624-0.761) †	1.39 (1.07-1.81) *	98.19*	906.36	975.63	0.719 (0.642-0.796) †
PP	1.06 (0.91-1.24)	82.48	1781.78	1851.15	0.687 (0.620-0.754)	0.75 (0.56-1.03)	95.69	908.86	978.13	0.721 (0.644-0.799)

Base model +dual BP measurements (Y₀)										
Model 1: SBP DBP	1.28 (1.05-1.58)* 1.10 (0.91-1.33)	92.21†	1774.06	1849.21	0.700 (0.629-0.763)†	0.85 (0.59-1.23) 1.64 (1.14-2.35)†	100.91†	905.63	980.68	0.724 (0.647-0.801)
Model 2: MAP PP	1.34 (1.12-1.60)† 1.13 (0.96-1.32)	92.21†	1774.06	1849.21	0.700 (0.629-0.763)†	1.37 (1.05-1.79)* 0.77 (0.56-1.06)	100.91†	905.63	980.67	0.724 (0.647-0.801)

Race-specific adjusted HRs (95% CIs) for risk of incident CVD with a 1SD increment in SBP, DBP, MAP, and PP are shown. 1 SD increment of each BP parameter at Y₀ is as follows: SBP, per 11 mm Hg; DBP 10mmHg; MAP, 9 mmHg; PP, 10 mmHg. Base model includes sociodemographic characteristics: age, sex, education, and study site (Birmingham, Chicago, Minneapolis, Oakland) and clinical characteristics at Y₀: smoking, body mass index, fasting glucose, total cholesterol/high-density lipoprotein cholesterol, and antihypertensive medication use. The differences from base model were statistically tested. Harrell's C was used to calculate C statistics.

HR indicates hazard ratio; CI, confidence interval; SD, standard deviation; SBP, systolic blood pressure; DBP, diastolic blood pressure; MAP, mean arterial pressure; PP, pulse pressure; AIC, Akaike information criterion; BIC, Bayes' information criteria. Statistical significance was defined as $P < 0.05$. * $P < 0.05$; † $P < 0.01$; ‡ $P < 0.001$.

eTable 5. Clinical Characteristics of Study Cohort by Race at Y₁₅

Descriptive variable	Blacks (n=1,994)	Whites (n=2,083)
Age, years	39.6±0.1	40.7±0.1
Men, %	41.6	46.6
Education, years	14.0±0.1	15.7±0.1
Body mass index, kg/m ²	30.5±0.2	27.2±0.1
Hypertension, %	24.0	9.2
Antihypertensive medication, %	11.8	3.6
Fasting glucose, mg/dL	87.7±0.6	85.7±0.4
Total cholesterol, mg/dL	183.0±0.9	186.7±0.8
High-density lipoprotein, mg/dL	51.5±0.3	50.2±0.3

Data are expressed as the means ± SE or percentage.

Y₁₅ indicates the Year 15 examination; SBP, systolic blood pressure; DBP, diastolic blood pressure; MAP, mean arterial pressure; PP, pulse pressure; SE, standard error.

eTable 6. Mean (SD) of BP at Y₁₅ With or Without Imputation

Descriptive variable	Multiple imputation for missing BPs at Y₁₅ (+)		Multiple imputation for missing BPs at Y₁₅ (-)	
	Blacks (n=1,994)	Whites (n=2,083)	Blacks (n=1,655)	Whites (n=1,879)
SBP, mmHg	117.1±15.9	109.8±12.9	116.9±15.9	109.7±12.9
DBP, mmHg	76.8±12.5	72.3±10.3	76.8±12.4	72.2±10.2
MAP, mmHg	90.2±12.8	84.8±10.4	90.2±12.8	84.7±10.4
PP, mmHg	40.2±10.4	37.5±8.7	40.1±10.4	37.5±8.7

Data are expressed as the means ± SD.

Y₁₅ indicates the Year 15 examination; SBP, systolic blood pressure; DBP, diastolic blood pressure; MAP, mean arterial pressure; PP, pulse pressure.

eTable 7. The Association Between Each BP Component at Y₁₅ and CVD Risk in Participants Without Receiving Antihypertensive Medication at Y₁₅: Race-Specific Hazard Ratios for Incident CVD Events

	Blacks (n=1,797)	Whites (n=2,016)
Composite CVD events, No. (per 1,000 person-years; 95% CIs)	67 (4.57; 3.59to 5.80)	41 (2.40; 1.76 to 3.25)
	HRs (95% CIs) per 1 SD of BP component	HRs (95% CIs) per 1 SD of BP component
Single BP measurement (Y₁₅)		
SBP	1.84 (1.49-2.27)‡	2.01 (1.41-2.87)‡
DBP	1.63 (1.30-2.05)‡	1.74 (1.23-2.46)†
MAP	1.71 (1.39-2.10)‡	1.88 (1.34-2.64)‡
PP	1.60 (1.26-2.04)‡	1.42 (0.98-2.07)
Dual BP measurements (Y₁₅)		
Model 1:		
SBP	1.96 (1.36-2.82)‡	1.88 (1.10-3.21)*
DBP	0.92 (0.63-1.35)	1.09 (0.66-1.83)
Model 2:		
MAP	1.58 (1.27-1.97)‡	1.81 (1.28-2.55)†
PP	1.38 (1.07-1.78) *	1.29 (0.90-1.84)

Of the 5,115 participants, we excluded 145 participants lost to follow-up, 2 participants identified as who underwent gender reassignment, a participant who withdrew study consent, 264 participants who received antihypertensive medication at Y₁₅, and those who had a CVD event (n=87) or were censored before the Y₁₅ examination (n=803). As a result, 3,813 participants were included in this analysis. Of the 3,813 participants, we imputed BP measurements for 542 participants.

Race-specific adjusted HRs (95% CIs) for risk of incident CVD with a 1SD increment in SBP, DBP, MAP, and PP are shown. 1 SD increment of each BP parameter at Y₁₅ is as follows: SBP, per 15 mm Hg; DBP 12mmHg; MAP, 12 mmHg; PP, 10 mmHg. In single BP measurement, each BP component was analyzed separately. In dual BP measurements, SBP and DBP or MAP and PP were analyzed jointly.

As adjustment factors, all models include sociodemographic characteristics: age, sex, education, and study site (Birmingham, Chicago, Minneapolis, Oakland) and clinical characteristics at Y₁₅: fasting glucose, and total cholesterol/high-density lipoprotein cholesterol.

No indicates number; HR, hazard ratio; CI, confidence interval; Y₁₅, year 15; SBP, systolic blood pressure; DBP, diastolic blood pressure; MAP, mean arterial pressure; PP, pulse pressure. Statistical significance was defined as $P < 0.05$. * $P < 0.05$; † $P < 0.01$; ‡ $P < 0.001$.

eTable 8. The Association Between Each BP Component at Y₁₅ (Without Multiple Imputation) and CVD Risk: Race-Specific Hazard Ratios for Incident CVD Events (n=3534)

	Blacks (n=1614)					Whites (n=1854)				
Composite CVD events, No. (per 1,000 person-years; 95% CIs)	63 (4.73; 3.70 to 6.06)					30 (1.89; 1.32 to 2.70)				
	HRs (95% CIs) per 1 SD of BP component	Likelihood Ratio χ^2*	AIC	BIC	C statistics (95% CIs)*	HRs (95% CIs) per 1 SD of BP component	Likelihood Ratio χ^2*	AIC	BIC	C statistics (95% CIs)*
Base model	-	47.06	870.94	919.42	0.649 (0.551-0.746)	-	37.25	421.82	471.55	0.681 (0.512-0.851)
<u>Base model +single BP measurement (Y₁₅)</u>										
SBP	1.61 (1.33-1.94)‡	67.86‡	852.14	906.00	0.721 (0.627-0.816)*	1.86 (1.28-2.70)	47.24	413.84	469.09	0.695 (0.516-0.875)
DBP	1.44 (1.16-1.78)†	57.10*	862.90	916.76	0.683 (0.586-0.780)	1.67 (1.18-2.36)†	45.05†	416.03	471.28	0.720 (0.563-0.878)
MAP	1.54 (1.27-1.88)‡	62.85†	861.63	915.50	0.699 (0.601-0.797)	1.83 (1.29-2.61)†	47.39*	413.68	468.93	0.719 (0.558-0.880)
PP	1.41 (1.17-1.70)	58.37	857.15	911.01	0.716 (0.620-0.754)†	1.18 (0.86-1.63)	38.32 *	422.76	478.01	0.679 (0.503-0.856)
<u>Base model +dual BP measurements (Y₁₅)</u>										
Model 1:										
SBP	1.68 (1.25-2.25)*	68.00†	853.99	913.25	0.728 (0.637-0.819)*	1.59 (0.96-2.63)	48.12†	414.96	475.73	0.713 (0.548-0.879)
DBP	1.10 (0.91-1.33)					1.24 (0.79-1.97)				

Model 2:										
MAP	1.42	68.00†	853.99	913.25	0.728	1.82	48.12†	414.96	475.73	0.713
PP	(1.15-1.76)†				(0.637-0.819)*	(1.27-2.59)†				(0.548-0.879)
	1.27					1.15				
	(1.04-1.56)*					(0.84-1.58)				

Race-specific adjusted HRs (95% CIs) for risk of incident CVD with a 1SD increment in SBP, DBP, MAP, and PP are shown. 1 SD increment of each BP parameter at Y_{15} is as follows: SBP, per 15 mm Hg; DBP 12mmHg; MAP, 12 mmHg; PP, 10 mmHg. Base model includes sociodemographic characteristics: age, sex, education, and study site (Birmingham, Chicago, Minneapolis, Oakland) and clinical characteristics at Y_0 : fasting glucose, total cholesterol/high-density lipoprotein cholesterol, and antihypertensive medication use. ✕The differences from base model were statistically tested. Harrell's C was used to calculate C statistics. HR indicates hazard ratio; CI, confidence interval; SD, standard deviation; SBP, systolic blood pressure; DBP, diastolic blood pressure; MAP, mean arterial pressure; PP, pulse pressure; AIC, Akaike information criterion; BIC, Bayes' information criteria. Statistical significance was defined as $P < 0.05$. * $P < 0.05$; † $P < 0.01$; ‡ $P < 0.001$.